

Europäisches Patentamt

European Patent Office

Office européen des brevets



(11) EP 0 735 641 A1

## (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:  
02.10.1996 Bulletin 1996/40(51) Int. Cl.<sup>6</sup>: H02J 7/24

(21) Application number: 95119637.7

(22) Date of filing: 13.12.1995

(84) Designated Contracting States:  
DE FR GB IT

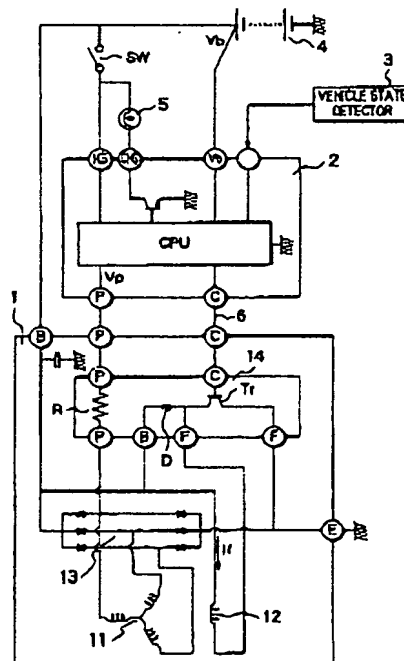
(30) Priority: 31.03.1995 JP 76346/95

(71) Applicant: MITSUBISHI DENKI KABUSHIKI  
KAISHA  
Tokyo 100 (JP)(72) Inventors:  
• Uchinami, Masanobu  
Chiyoda-ku, Tokyo 100 (JP)• Morishita, Akira  
Chiyoda-ku, Tokyo 100 (JP)  
• Adachi, Katsumi  
Chiyoda-ku, Tokyo 100 (JP)(74) Representative: Ritter und Edler von Fischern,  
Bernhard, Dipl.-Ing. et al  
Hoffmann, Eitle & Partner,  
Patentanwälte,  
Arabellastrasse 4  
81925 München (DE)

## (54) Charge control system for use in internal combustion engine

(57) A charge control system for an internal combustion engine which is capable of suppressing electromagnetic noise due to a control signal to a generator and of preventing an over-charge to a battery even if an input terminal receiving the control signal is grounded. The charge control system is composed of a generator (1) driven by an engine of a motor vehicle and a battery (4) charged with the output of the generator (1). Also included in the system is a computer unit (2) comprising a microcomputer CPU for calculating a target voltage  $V_{reg}$  on the basis of the operational states of the motor vehicle to compare a battery voltage  $V_b$  with the calculated target voltage  $V_{reg}$  so as to output a drive signal in accordance with the comparison result. This drive signal operates a transistor (Tr), incorporated into the generator, to control a field current  $I_f$  of the generator (1) so that the quantity of the power generation of the generator (1) increases and decreases to control the quantity of the charge to the battery (4).

FIG. 1



## EP 0 735 641 A1

## Description

## BACKGROUND OF THE INVENTION

## 5 FIELD OF THE INVENTION

The present invention relates to a charge control system for controlling a charge to a battery due to a generator (dynamo) to be driven by an internal combustion engine, and more particularly to a charge control system including a microcomputer for electronic-controlling the output of the generator for the charging of a battery.

10

## DESCRIPTION OF THE PRIOR ART

Japanese Patent Publication No. 6-67133, for example, discloses a microcomputer-based, electronic-controlled alternating-current (AC) generator for motor vehicles, wherein a microcomputer controls its field current to increase and decrease the quantity of the power generation, i.e., the quantity of charge to a battery on the basis of the detection results of various sensors such as a battery temperature sensor, a vehicle speed sensor, and a throttle sensor for detecting an opening degree of a throttle valve. Such a microcomputer-controlled AC generator is equipped with a transistor serving as an electronic switching device at a microcomputer-incorporated computer unit side, which transistor controls a current (field current) flowing into a field coil of a generator. In response to the control of the field current, the output voltage of the generator is controlled to a given value, while charging the battery under this control. As a rule, a generator is disposed in an engine room, whereas a computer unit is located in a passenger compartment of a motor vehicle. For this reason, wires connecting between the generator and the computer unit become relatively long, e.g., 2 to 3 meters long, so that large electromagnetic noise is caused by a current of approximately 4A usually flowing into the field coil of the generator, thus greatly affecting a vehicle-mounted radio and other electric articles or accessories. For suppression of such electromagnetic noise, countermeasures have been taken, for example, the ON/OFF operating speed of the aforesaid transistor is made to be slow or a noise-preventing filter is provided to prevent the noise from leaking to the outside of the computer unit. These noise countermeasures raise its manufacturing cost, while requiring much time and work for confirmation of its effects in a development stage.

Moreover, in such a prior system, the field-current controlling transistor is located at a downstream side (grounded side) of the field coil and the wires connecting between the generator and the computer unit are disposed at an upstream side of the transistor, with the result that, if the connecting wires or a terminal at the generator or computer unit side accidentally gets into a grounded state, the field current continues to flow without passing through the transistor. This trouble makes it difficult to control the quantity of the power generation, thus bringing the generator continuously into the power-generating state to cause an overcharge.

35

## SUMMARY OF THE INVENTION

The present invention has been developed with a view to eliminating above-mentioned problems, and it is therefore an object of the present invention to provide a charge control system for an internal combustion engine which is capable of suppressing electromagnetic noise caused by the ON/OFF action of a transistor and further of stopping the generating operation of a generator to avoid the overcharge to a battery if a grounding trouble takes place for some reason.

In accordance with the present invention, a charge control system for an internal combustion engine comprises a generator driven by the internal combustion engine to generate electric power, an electronic switching device built in the generator and operable with a limited current for controlling a field current of the generator, a battery charged by an output of the generator, and a computer unit coupled to the generator and further to the battery for comparing a voltage of the battery with a target (reference) voltage to output a drive signal in accordance with the comparison result so that the electronic switching device is driven to control the field current of the generator to increase and decrease the quantity of power generation due to the generator to control the quantity of charge to the battery.

With this arrangement, the generator is controlled with a limited current from the computer unit so that the generation of electromagnetic noise can be reduced up to a level that hardly cause a problem, with the result that countermeasures such as the provision of a noise preventing filter for suppressing electromagnetic noise becomes unnecessary, which can avoid an increase in manufacturing cost and which makes it unnecessary to take much time and work for confirmation of its effects in a development stage, with an exceedingly decreased number of manufacturing steps.

In a preferred form of this invention, the charge control system further comprises a field current control circuit for inhibiting the flow of the field current in cases where, of terminals of the electronic switching device incorporated into the generator, an input terminal receiving a drive signal from the computer unit comes into a grounded condition.

Thus, the field current control circuit is constructed such that when the drive signal input terminal of the electronic switching device incorporated in the generator is grounded for some reason, the field current does not flow, with the

## EP 0 735 641 A1

result that the generating operation of the generator stops to prevent the overcharge to the battery even if the grounding trouble occurs.

In another preferred form of this invention, the drive signal for driving the electronic switching device has a predetermined fixed frequency, and the duty ratio is controlled in accordance with a deviation between the target voltage and the voltage detected.

That is, the electric switching device is driven with the duty ratio corresponding to the deviation of the battery voltage from the target voltage so as to control the field current. Accordingly, in addition to this arrangement permitting finer charge quantity control, because the electronic switching device is built in the generator, the electronic switching device is operable with a small or limited current even if the drive signal has a high frequency, thus suppressing the occurrence of the electromagnetic noise.

## BRIEF DESCRIPTION OF THE DRAWINGS

The object and features of the present invention will become more readily apparent from the following detailed description of the preferred embodiments taken in conjunction with the accompanying drawings in which:

Fig. 1 is a circuit diagram showing an arrangement of a charge control system for an internal combustion engine according to this invention;

Fig. 2 is a cross-sectional view showing a structure of a generator of the charge control system according to this invention; and

Fig. 3 is a flow chart showing an operation of a computer unit of the charge control system according to this invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

A description will be made hereinbelow of preferred embodiments of the present invention with reference to the drawings.

## First Embodiment

Fig. 1 shows in a diagrammatic form an arrangement of a charge control system for an internal combustion engine according to a first embodiment of this invention, and Fig. 2 shows in cross section a construction of a generator used in the charge control system. In Fig. 1, a charge control system for an internal combustion engine (which will hereinafter be referred to as a charge control system) is equipped with a generator 1 driven by an internal combustion engine of a motor vehicle such as a car, a computer unit 2 for controlling the output of the generator 1, a vehicle state detector 3 for detecting the operational states (for example, a battery temperature, vehicle speed, and throttle opening degree) of the motor vehicle necessary for calculations the computer unit 2 performs, and a battery 4 charged by the output of the generator 1. More specifically, the generator 1 is provided with a three-phase armature coil 11 and a field coil 12, the output thereof being made to increase and decrease in such a way that a field current  $I_f$  flowing through the field coil 12 is controlled with an electronic switching device operable with a small or limited current and driven in accordance with a drive signal from the computer unit 2. In addition, the output of the generator 1 is rectified with a built-in three-phase full-wave rectifier 13.

In this embodiment, the electronic switching device is composed of a transistor  $Tr$  which, as shown in Fig. 2, is mounted on an IC substrate 14 disposed in the vicinity of a brush 21 in a bracket 22. In addition to the transistor  $Tr$ , the IC substrate 14 has a commutation diode  $D$  and a resistor  $R$  for protecting the computer unit 2 against a short-circuit current.

The computer unit 2 includes a microcomputer CPU which outputs a drive signal for operating the transistor  $Tr$  on the basis of the detection results of the vehicle state detecting 3, a voltage  $V_b$  of the battery, and the like. This microcomputer CPU also executes the fuel injection control and the ignition timing control for the motor vehicle, whereas the description of these operations will be omitted because of being not directly associated with this invention. Moreover, the computer unit 2 receives, as an input, the output ( $V_p$ ) of the generator 1, corresponding to one phase, through a smoothing circuit, not shown. On the basis of this input, the computer unit 2 checks whether or not the battery is normally charged with the output of the generator 1, and further executes a charge display control operation, i.e., turns a charge (CHG) lamp 5 on to give an alarm. The generator 1 and the computer unit 2 are in a coupled relation to each other through a lead wire 6. Further, the computer unit 2 comes into connection with the battery 4 through a main switch SW.

Secondly, a description will be taken in conjunction with Fig. 3 in terms of an operation of the computer unit 2. This operation begins with a step S1 to detect operational states of a motor vehicle using the vehicle state detector 3, then followed by a step S2 to determine a target voltage  $V_{reg}$  for the generator 1 on the basis of the detection results in the

## EP 0 735 641 A1

step S1. The operational flow advances to a step S3 to detect the battery voltage  $V_b$  and then proceeds to a step S4 to compare the detected battery voltage  $V_b$  with the determined target voltage  $V_{reg}$  in the step S2. If  $V_{reg} > V_b$ , the operational flow goes to a step S5 to issue a high-level signal to turn the transistor  $Tr$  on. On the other hand, if no  $V_{reg} > V_b$ , the operational flow advances to a step S6 to produce a low-level signal which in turn, causes the transistor  $Tr$  to get into an off state. With such an ON/OFF drive of the transistor  $Tr$ , control is made for the field current  $I_f$  flowing through the field coil 12. Subsequently, after the completion of the step S5 or S6, a step S7 follows in order to check whether the output  $V_p$ , corresponding to one phase, of the armature coil 11 of the generator 1 is present within a predetermined range. That is, if the  $V_p$  is within the predetermined range, the operational flow proceeds to a step S8 wherein, assumed that the output of the generator 1 is sufficient to charge the battery 4, the charge lamp 5 constituting the alarm turns off, and the operation terminates. On the other hand, if the  $V_p$  is out of the predetermined range, the operational flow goes to a step S9 in which the output of the generator 1 is considered to be abnormal so as to stop the normal charge to the battery 4, and the charge lamp 5 exhibits an alarm, before the operation completes.

As described above, since the transistor  $Tr$  driven in accordance with the calculation results of the computer unit 2 is incorporated into the generator 1 so as to execute the control of the field current  $I_f$ , the output of the generator 1 is controllable with a limited current (approximately 10 mA) representative of a signal from the computer unit 2. This arrangement permits the electromagnetic noise to be reduced up to a level which hardly suffers from a problem, with the result that the countermeasures such as the provision of a noise preventing filter for suppressing the electromagnetic noise becomes unnecessary, which can avoid the increase in manufacturing cost and which makes it unnecessary to need much time and work for confirmation of its effects in a development stage, with an exceedingly decreased number of manufacturing steps.

Still further, as shown in Fig. 1, the transistor  $Tr$  built in the generator 1 can be positioned at an upstream side of a lead wire 66 for connection between a terminal C of the generator and a terminal C of the computer unit 2, and hence, even if these terminals C and the lead wire 6 are grounded for some reason, the transistor  $Tr$  turns off irrespective of the drive signal from the computer unit 2 to inhibit the flow of the field current  $I_f$ , with the result that the generator 1 stops its power generation to prevent the overcharge to the battery 4.

## Second Embodiment

Although in the foregoing first embodiment the target voltage  $V_{reg}$  calculated in the computer unit 2 is compared with the detected battery voltage  $V_b$  so that a high-level or low-level signal is outputted in accordance with the comparison result, in this second embodiment, for the control of the quantity of the power generation, a drive duty ratio  $D_f$  is calculated by an equation, as will be described later, as a function of a deviation  $\Delta V$  in voltage between the target voltage  $V_{reg}$  and the battery voltage  $V_b$  in accordance with a PID control method so that the transistor  $Tr$  is driven with a predetermined fixed frequency, for example, 200 Hz, of drive duty signal. This can exhibit the same effects as those of the foregoing first embodiment. In addition, when the transistor  $Tr$  is subjected to the ON/OFF control with a high fixed frequency, the countermeasures for the electromagnetic noise are further required, while the arrangement according to this embodiment can show a large effect for suppression of the electromagnetic noises.

The aforesaid equation is as follows:

$$D_f = K_p \times \Delta V + K_i \times \Delta t + K_d \times (\Delta V(i) - \Delta V(i-1))$$

where  $K_p$  represents a constant of proportion,  $K_i$  designates an integration constant,  $K_d$  depicts a differentiation constant,  $\Delta V(i)$  denotes the present voltage deviation, and  $\Delta V(i-1)$  signifies the previous voltage deviation.

It should be understood that the foregoing relates to only preferred embodiments of the present invention, and that it is intended to cover all changes and modifications of the embodiments of the invention herein used for the purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention. For example, although the above descriptions have been made of the control of the change voltage to the battery due to the generator of a motor vehicle such as a car, this invention is also applicable to other common generators. In addition, although the transistor  $Tr$  has been used as an electronic switching device, any electronic device other than the transistor is available if taking the ON/OFF action with a limited current.

## Claims

1. A charge control system for an internal combustion engine, comprising:

- a generator driven by said internal combustion engine to generate electric power;
- an electronic switching device built in said generator and operable with a limited current for controlling a field current of said generator;
- a battery charged with an output of said generator; and

## EP 0 735 641 A1

a computer unit coupled to said generator and further to said battery for comparing a voltage of said battery with a target voltage to output a drive signal in accordance with the comparison result to drive said electronic switching device so that said field current of said generator is controlled to increase and decrease a quantity of its power generation to control a quantity of charge to said battery.

5

2. A charge control system as defined in claim 1, further comprising a field current control circuit for inhibiting a flow of said field current in cases where, of terminals of said electronic switching device incorporated into said generator, an input terminal receiving said drive signal from said computer unit comes into a grounded condition.

10

3. A charge control system as defined in claim 1, wherein said drive signal for driving said electronic switching device has a predetermined fixed frequency, and a duty ratio of said drive signal is controlled in accordance with a deviation between said target voltage and said battery voltage.

15

20

25

30

35

40

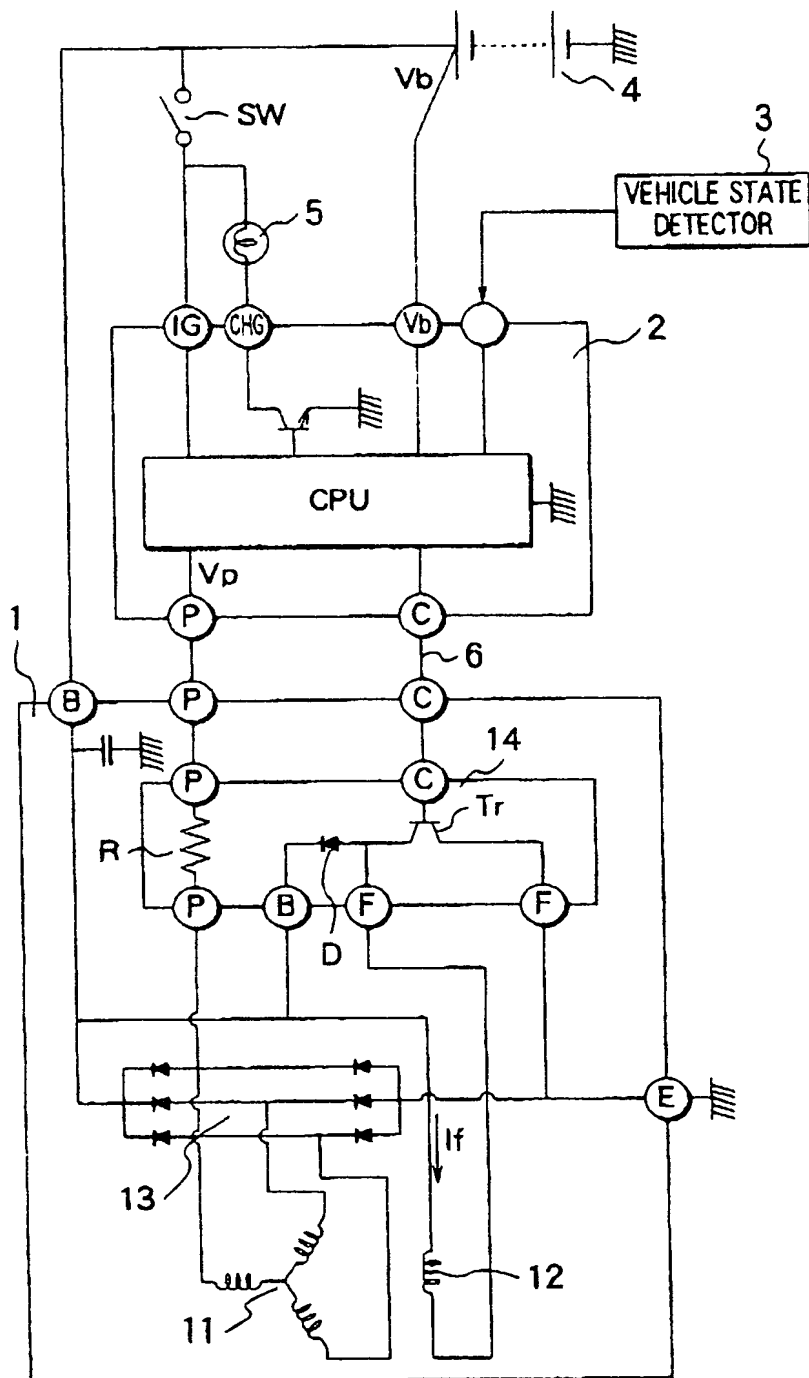
45

50

55

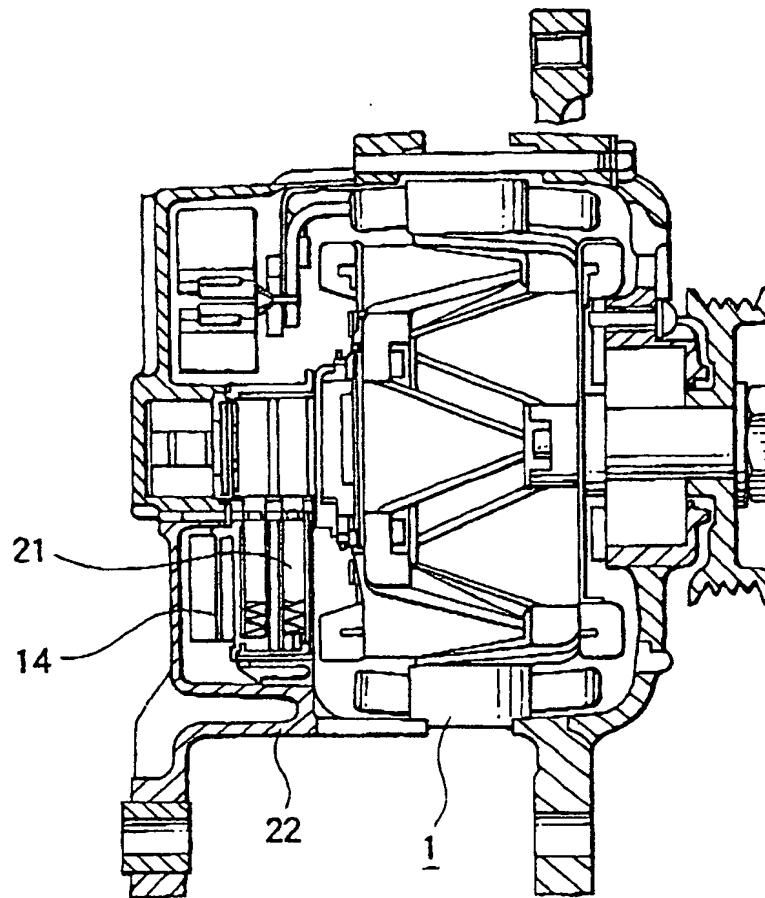
EP 0 735 641 A1

FIG. 1



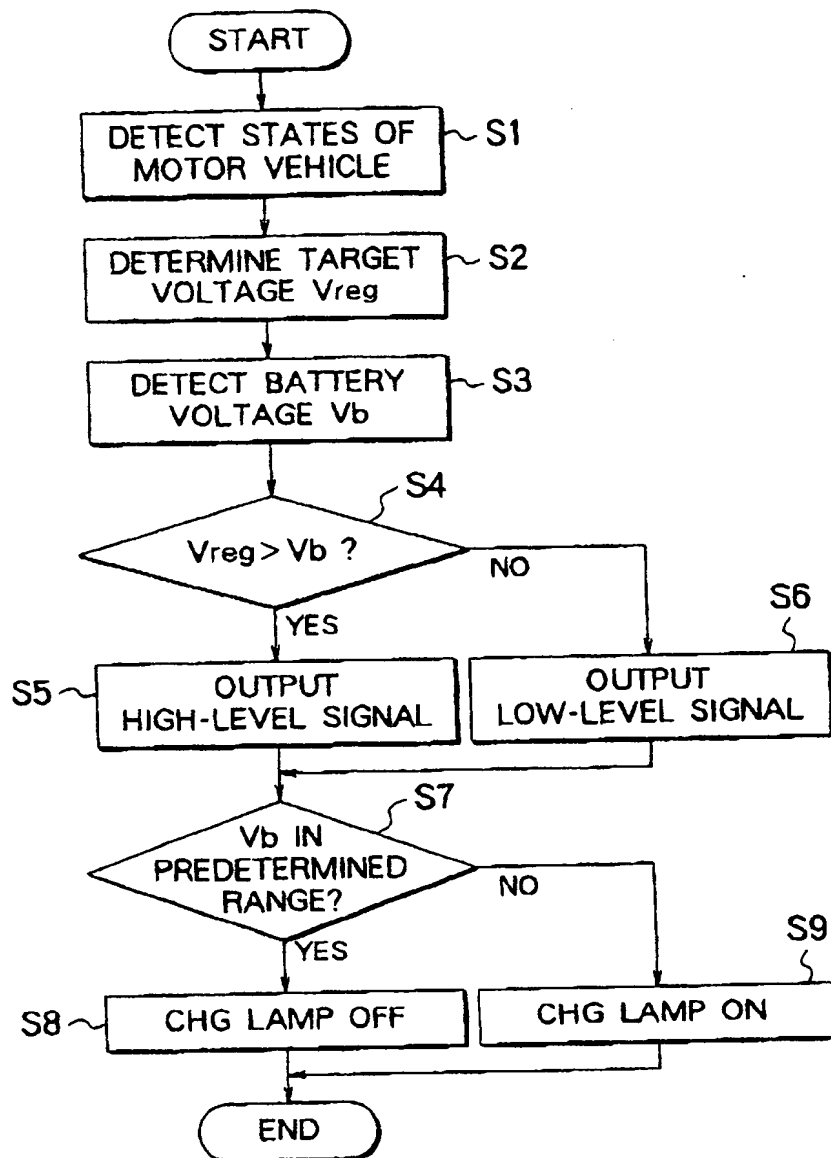
EP 0 735 641 A1

FIG. 2



EP 0 735 641 A1

FIG. 3





EP 0 735 641 A1

European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
EP 95 11 9637

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (In CL6)
Y	US-A-4 651 081 (NISHIMURA SHINJI ET AL) 17 March 1987 * column 4, paragraph 3 - paragraph 4; figure 2 * * column 8, paragraph 4 - column 9, paragraph 1; figure 10 *	1-3	H02J7/24
Y	DE-A-26 43 612 (HITACHI LTD) 28 April 1977 * claim 1; figure 2 *	1.2	
Y	DE-A-43 21 970 (HITACHI LTD ;HITACHI AUTOMOTIVE ENG (JP)) 5 January 1994 * column 1 - column 2 * * column 15, line 66 - column 16, line 33; figure 16 *	3	
A	EP-A-0 438 884 (HITACHI LTD) 31 July 1991 * claim 18; figure 1 *	1-3	
A	DE-A-41 08 751 (HITACHI LTD) 26 September 1991 * column 5, paragraph 3 - paragraph 5; figure 2 *	1-3	
			TECHNICAL FIELDS SEARCHED (Int. CL.6)
			H02J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 31 May 1996	Examiner Moyle, J
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 150 (01/91) (P0101)